COLLECTION AND PRESERVATION OF INSECTS AND OTHER MATERIAL FOR USE IN THE STUDY OF AGRICULTURE

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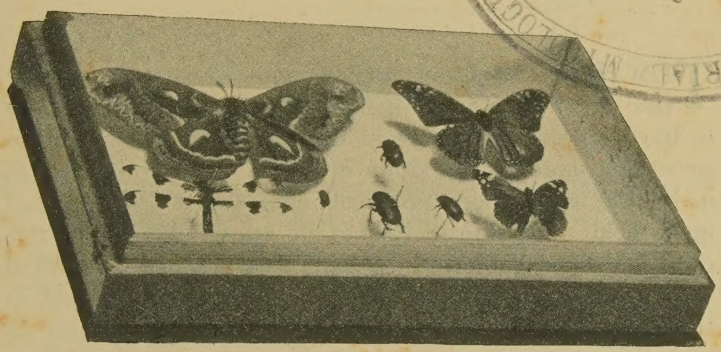

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TEACHERS of nature study and of elementary agriculture are beginning to realize that if these subjects are to have a permanent place in the curriculum, they must be something more than a study of books. In the attempt to make the work more practical, emphasis is being placed upon field practicums, observation trips, laboratory exercises, and home projects. In connection with such practical work, there is need for greater effort to stimulate interest in the recitation and a closer linking of the work of the classroom with the practical work. Inasmuch as a proper use of illustrative material will do much toward arousing interest and making the subjects of nature study and agriculture more vital, the following pages give suggestions concerning the collection and preservation of insects and other material for use in rural schools.

P.A.B

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THIS bulletin suggests methods of collecting, preparing, mounting, and preserving insect specimens and other illustrative materials of various sorts which can be used by teachers of agriculture,[1] particularly those teachers who have not had special training along agricultural lines and who will therefore doubtless welcome specific information as to how to prepare materials needed for illustration and experimental use in the classroom.

WHAT MATERIALS SHOULD BE COLLECTED.

The nature of the material which the teacher should aim to collect will depend, of course, upon the character of the school and the class of work which is taken up, as well as upon the locality, the funds available, and the time which can be devoted to the work.

In general the illustrative materials with which every school should be provided may be grouped into two classes, according to the uses to which they are to be put: (1) Museum specimens and samples which are to be kept permanently for reference, display, and strictly illustrative purposes only; and (2) working collections, which may be used for display and illustration, but the chief purpose of which is to supply the students with materials for class study and experimental use. For instructional purposes the latter is by far the more valuable, but a permanent collection of insect specimens and samples of various other materials may be very useful to any school, provided, of course, the specimens are accurately labeled and so preserved and

[1] Methods of collecting plant materials for this purpose are described in Farmers' Bulletin 586, which can be had on application to the United States Department of Agriculture, Washington, D. C.

mounted that they are readily available for examination. It is with the solution of this problem that it is intended to deal particularly in this bulletin.

Materials for class use should, as far as possible, be fresh and in the natural state rather than in mounted form, and will therefore generally be collected just prior to the time they are wanted and put away only temporarily. No great degree of care or skill will, in general, be necessary to do this, but the preparation of materials for the permanent collection in a school museum often requires considerable technical knowledge and ingenuity in preparing and preserving the specimens and preparing convenient receptacles in which to keep them. This is particularly true where the means at hand are limited and the resourcefulness of the teacher must be relied upon to produce inexpensive methods and devices of home manufacture.

SOURCES OF THE MATERIAL.

In recent years many commercial houses, educational institutions, and Government bureaus have distributed collections of specimens and samples of various sorts to schools. Such collections are of great value, undoubtedly, and there is no objection whatsoever to schools securing materials from such sources whenever possible, so long as they do not rely upon these sources for all their illustrative material. It is, however, a much better policy to attempt, as far as possible, to have the pupils collect and prepare their own materials from original local sources, because of the possibilities for educative work involved in the process of gathering the various specimens.

Every community affords opportunities for collecting insects and other materials of vital importance in the study of agriculture, and the work of gathering these specimens will afford definite tasks upon which to center the interest of numerous field trips, so that the danger of aimless wandering, which so frequently makes this method of instruction devoid of practical results, may be minimized. The instructor who takes his class out into the field or orchard with the definite purpose to collect insects, for example, has the very best possible opportunity at the same time to teach, not only identification of the local insect species, but also useful facts as to their economic importance.

GENERAL SUGGESTIONS FOR FIELD WORK.

It is important that the pupils should be provided with notebooks and pencils for making complete and accurate records which should be kept for each specimen collected, in order to supply the data necessary for the proper labeling of the mounted specimen.

All work of this sort should be constructive and never destructive. Wanton destruction of insects, except those which are injurious to man or his crops, should be denounced and the young encouraged to watch the living insects and learn all they can of their habits.

SUGGESTIONS CONCERNING THE ARRANGEMENT OF MATERIALS.

When insects or other materials are collected for ordinary purposes of study and reference, it will generally suffice to arrange the specimens in their logical order, according to their scientific classifications. When, however, it is intended to prepare a set of specimens for an educational display, very interesting and attractive groups can be arranged to show strikingly the agricultural relationships of the particular insects in question. For example, a display might be centered about some farm insect pest which would show the insect in various stages of its development; specimens of the plants upon which it feeds, showing the injury it does to these plants; specimens of other insects which are hostile to it; and pictures of birds which prey upon it. Exhibits such as this take time to prepare, but they will prove enough more attractive than an ordinary collection to warrant the extra labor and thought involved in their preparation.

COLLECTION OF INSECTS.

WHAT INSECTS TO COLLECT.

When proper methods are followed, the collection of insect specimens can be made the basis of a great deal of useful instruction in connection with the subject of agriculture. There are numerous species that are really beneficial to the farmer, and these should, of course, be studied, but one generally thinks of insects as injurious to agricultural interests because of the great number of species that are annoying about the household or injurious to farm animals or farm crops. These insect pests should form the basis of most of the work of the class in agriculture rather than the butterflies and harmless insects of purely entomological interest, or even the beneficial species.

It should be the aim of the student of agriculture to collect and become familiar with not only the adult forms of these insects, but also their larvæ and pupæ, since it is often in the larval stage that these pests are most injurious. Further, the pupil should become familiar with the life histories of the various species, since this will often furnish the key to the proper methods of combating the pests.

EQUIPMENT FOR INSECT-COLLECTING TRIPS.

The articles necessary for collecting insects are not very numerous and such as are most needed can be made by the pupils or the teacher with very little expense or trouble. The necessary equipment for an insect-collecting excursion should include collecting nets, killing bottles, a box containing some vials partly filled with alcohol in which to place specimens of larvæ and pupæ, a trowel for digging specimens out of the earth, a small hatchet for breaking open rotten stumps, some sheets of newspaper or other soft paper, size about

3 by 5 inches, for making envelopes in which to put delicate specimens of butterflies or moths, a small bottle of chloroform or gasoline, and a small hand satchel, haversack, or botanical specimen case, with a few small pasteboard boxes, such as pill boxes, in which to put insects after taking them out of the killing bottle. A small pair of forceps or tweezers will also be found convenient for handling some of the specimens, and a pocket lens will be a desirable aid for the study of the specimens in the field.

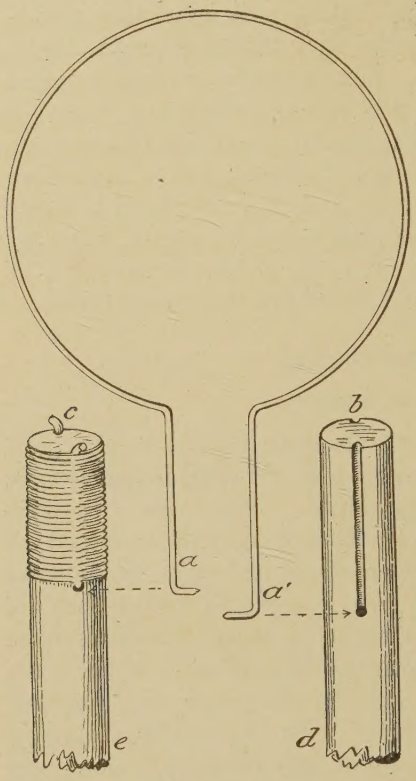


FIG. 1.—Homemade ring and handle: *a a'*, ring; *b*, stick showing grooves ending in hole; *c*, wire inserted in groove and hole, and wrapped with twine.

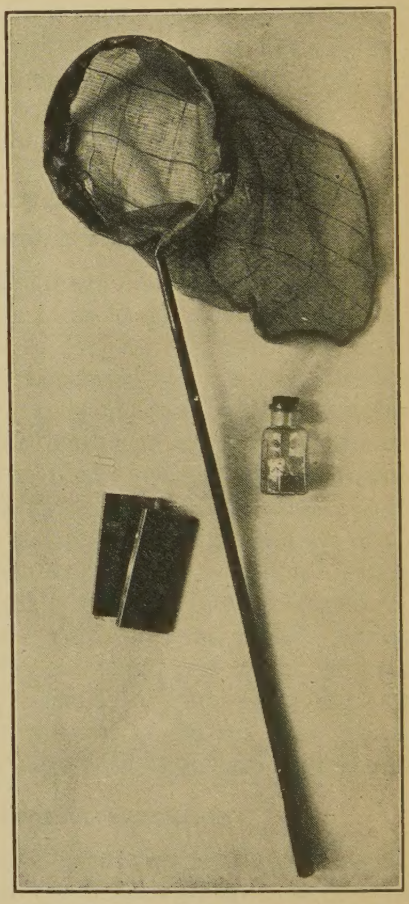


FIG. 2.—Net and killing bottle for insect collecting.

THE INSECT NET.

Anyone can make a satisfactory insect net (figs. 1 and 2). All that is necessary is a bag of thin material, a ring to support the bag, and a handle to be fastened to the ring. Bags are made of various materials. For beating through weeds and bushes it is best to have a bag of stout material, as twilled muslin or light duck cloth. For capturing butterflies and most flying insects a light net of cheese cloth or mosquito netting does very well for the beginner. The material should be such as not to stiffen or kink by use. Expert collectors often use bags of silk.

As a rule the length of the bag should be twice its diameter. The common size is 1 foot in diameter and 2 feet long. The bag is best if made to taper a little at the bottom, and the edges should be double hemmed (French seamed), so as to leave no free edge that may fray out. If the bag is of light material, it should be sewed to a band of stout muslin at the top. This band should be double and open at each end for the insertion of the ring, or else sewed on the ring. The ring may be of any heavy wire about the size of telephone wire. Bought rings usually have two or three joints to allow for folding, but although this is convenient for packing it is not important. The wire should be several inches longer than necessary to form the ring, the extra length bent at right angles, and the last half inch again bent at right angles. The stick or handle, about 2 or 2½ feet long, should be stout but not too heavy. A groove almost the size of the wire should be cut on each side near the end of the stick, ending in a hole, then the bent ends of the ring should be inserted in the hole and all wound tightly with twine, or a metal jacket slid over the ends to hold them in place. A longer and lighter handle of bamboo is better for collecting butterflies and dragon flies. It will be necessary to leave a few inches near the upper end of the bag unsewed in order that the ring can be inserted into the band. This part can be laced up with a string and the ends of the string tied to the handle. This will keep the net from slipping around on the ring.

For catching small insects a midget net of 5 or 7 inches in diameter is useful and can be made on the same plan as the larger one. The ends of the wire of the net can be inserted in a spool and a stick for the handle wedged in between the ends of the wire. This net is very handy for collecting insects from flowers and, in fact, for general collecting. The material for the bag of the midget net should be very light; white China silk lining is a good material.

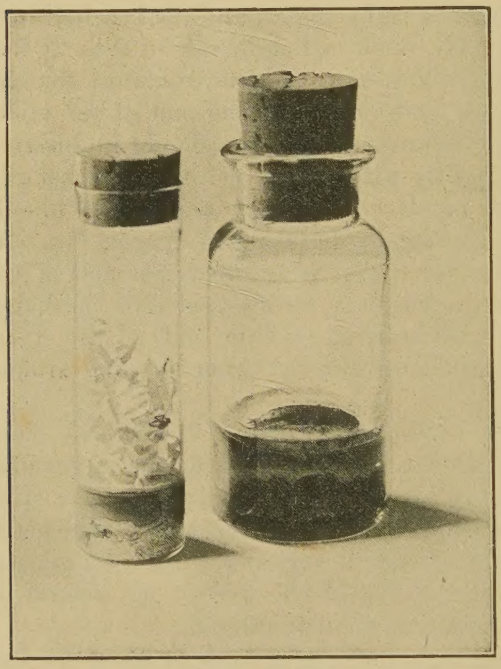
For collecting aquatic insects a more open mesh or sieve net can be attached to an iron frame which is straight on one side and bowed up on the other. With cords attached to each side this may be thrown into the water and, after sinking to the bottom, drawn to shore. Dredging among the weedy or sedgy parts of a pond is especially productive of insects.

Many insects are attracted to lights, and a strong lamp with a reflector to throw the light upon a white sheet will serve to attract many insects, particularly on sultry nights. A mixture of sugar or molasses and decaying apples smeared on trees in the woods will often attract moths at night. A bull's-eye lantern is useful in examining these patches in the evening.

Many insects that occur on the trunks of trees may be captured easily by putting a small cyanid vial over them; thus one avoids

handling the specimens. For collecting insects from the branches and leaves of trees, an inverted umbrella is the most useful implement. Hold it at arm's length under the tree and jar the limb with a heavy stick. A sudden shock will dislodge many beetles and other insects that one would not have noticed upon the tree.

Cans or bottles sunk in the ground so that the top is even with the top of the soil and baited with meat, a dead mouse, rotten apples, etc., will be visited by various insects. Boards or pieces of bark left on the ground near the edges of woods and meadows will serve as shelters for a variety of insects, and if visited occasionally one will find many interesting specimens. Always turn back stones, logs, or boards after examining them so that they will continue to attract insects.



THE KILLING BOTTLE.

Many insects occur among dead leaves and moss. These may be sifted out on a white paper or cloth by the use of a sieve similar to an ash sieve but with a finer mesh. On collecting trips one should take along some empty pill boxes or larger tin boxes for caterpillars and other larvæ.

One must always be careful in taking insects from a net not to crush them nor rub the scales from the wings of butterflies and moths. Always handle specimens as little as possible.

THE KILLING BOTTLE.

After the insect is caught it is necessary to kill it with as little pain to the creature as possible and without damaging the specimen. Insects are so different from human beings and their sensations appreciated through much less perfect organs and their brains of such a very inferior nature that it is improbable they feel much pain through death. Many insects can have their legs and other parts broken from them without incapacitating them in any way, and many kinds have parasites living within them and feeding on

their internal organs without their exhibiting any sign of pain; so there is no need to feel that we are harming helpless creatures by collecting insects. Still, for the sake of the effect on the collector, it is not well to gather nor destroy more than is necessary for this purpose.

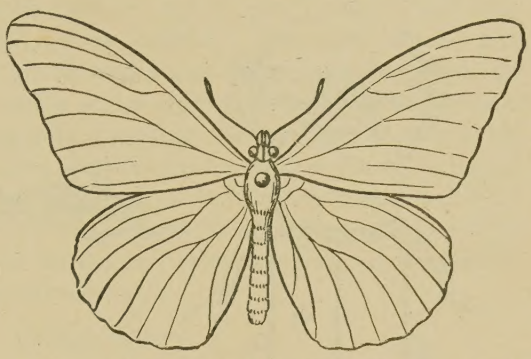


FIG. 4.—Method of pinning butterflies.

Insects may be killed by a vapor of chloroform, ether, sulphur smoke, etc., but by far the best way is by the vapor of potassium cyanid. This potassium cyanid is a hard white substance which can be purchased at drug stores. It is a deadly poison. The cyanid may be broken into small lumps, put in a bottle, covered with a little dry plaster of Paris, and then with a layer of plaster of Paris mixed with water so as to cover the cyanid about one-quarter of an inch. The bottle should be left open an hour or so to dry, and then kept tightly

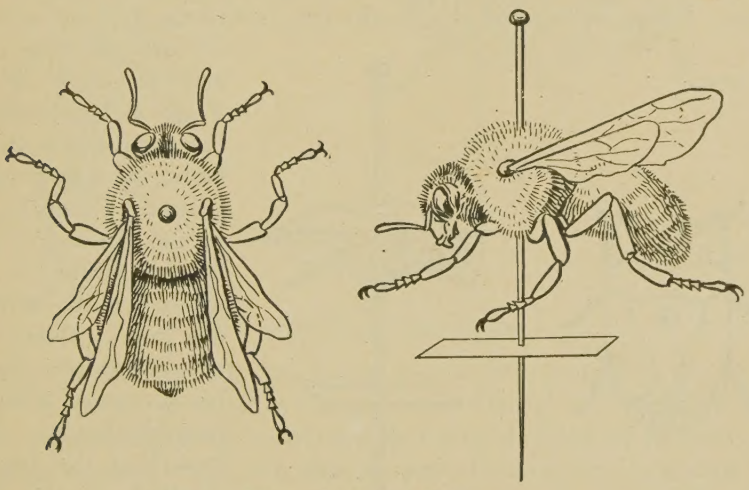


FIG. 5.—Method of pinning bees.

corked so that the fumes of the cyanid will be strong enough to kill an insect in a few moments (fig. 3). A label with the word "Poison" should be pasted upon it. It is well to place some crumpled strips of soft paper in the bottle to absorb any moisture and to prevent the insects from shaking against each other. A well-made poison bottle will last several years. The bottle should be of thick

glass, with a wide mouth and a tight-fitting cork that does not set down too far for convenient handling. Some make a poison bottle by wrapping bits of cyanid in soft paper and covering all with blotting

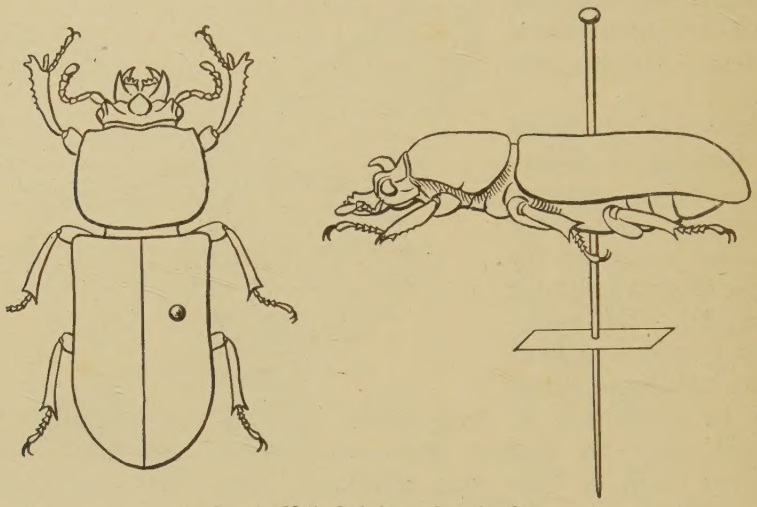


FIG. 6.—Method of pinning large beetles.

paper wadded down in the bottom of the bottle. This does very well for a small bottle but one should be very careful to have bottles of thick glass. Potassium cyanid is a deadly poison and the greatest amount of care must be exercised in handling it and if any is left over or a bottle broken it should be buried deeply in the ground. Poison bottles should not be left open in the room nor left where small children can get at them, and older children should be impressed with the possible danger. It is best that the teacher should have all the bottles returned after each collecting trip.

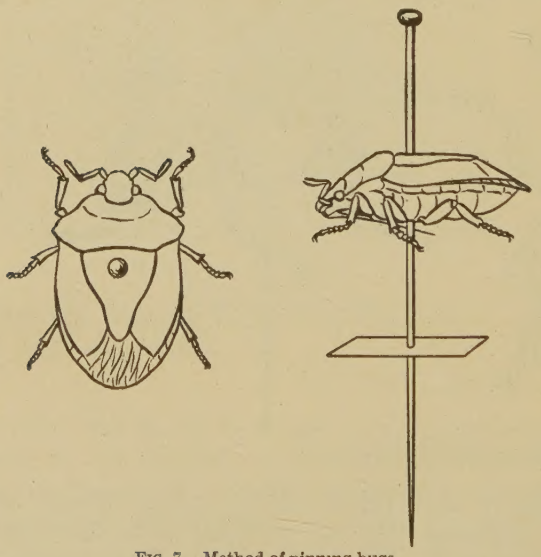


FIG. 7.—Method of pinning bugs.

Specimens should not remain in the poison bottle more than a day or two. In fact, insects with yellow markings should not be left in over night as the yellow will turn to red.

Most entomologists use many small cyanid vials or bottles of only about ½ to 1 inch diameter and 2 to 4 inches long. By taking several of these along on a trip, it is possible to keep insects of different sizes and kinds separate, for small flies are apt to get broken if put into the same bottle with large, heavy beetles. It is best not to put moths and butterflies in a bottle with other insects, as the latter are apt to become covered by loose scales from the moths or butterflies.

There is much less danger in handling insects than is popularly believed, since but few species are either poisonous or likely to injure the collector by biting or stinging. Insects like the wasps and bees will sting, of course, and a few of the larger beetles may pinch or bite, but these are generally well known and there are but comparatively few insects whose bites are poisonous.

PINNING INSECTS.

Common pins are too large for most insects, and so entomologists use a longer and more slender pin. These pins can be purchased from dealers in natural-history supplies. They are made bright,

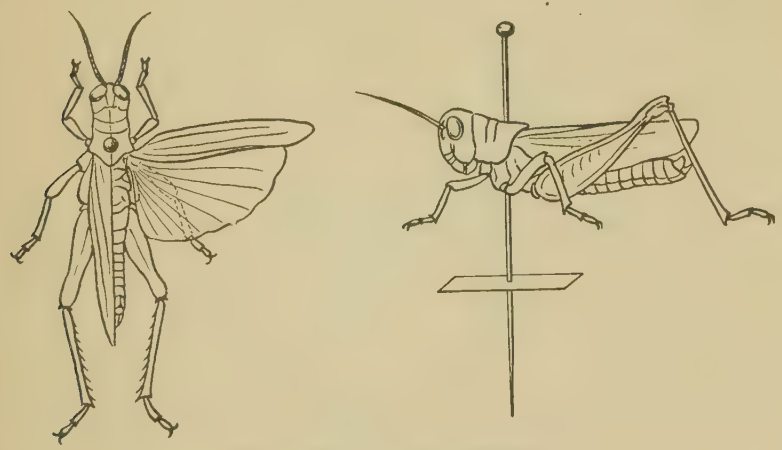


FIG. 8.—Method of pinning grasshoppers.

black, or japanned. The black pins cost a little more, but are much better for most insects, since the specimens will not verdigris. Verdigris is a poisonous green substance that may develop on an insect at the point where a bright pin goes through the specimen; it injures the specimen and eventually may destroy the pin. Some insects never verdigris, but those insects which feed on woody substances and many that live in the water are very apt to verdigris if pinned with a bright pin. The pins come in sizes according to number. No. 2 is a very good size for most insects, No. 1 for small insects, and No. 3 or 4 for the large ones. For use in school collections No. 2 will be the best size.

Most insects, like butterflies, moths, bees, and flies, should be pinned through the middle of the thorax (that part of the body to which the wings are attached) (figs. 4 and 5), but beetles should be pinned near the upper end of the right wing-cover (fig. 6), and true bugs through the scutellum (a triangular piece between the bases of the wings) (fig. 7). Grasshoppers are often pinned through the tip of the prothorax, a little in front of the base of the wings (fig. 8). The insect should be pushed fully two-thirds of the way up on the pin, and the collection will make a much better appearance if all the specimens are of an even height. Those specimens too small for a pin should be mounted on micropins (short pieces of slender wire having a pointed end) or glued on the ends of slender triangular pieces of cardboard called points (fig. 9). When the micropin is used, it is put into one end of a small oblong piece of cork and a large pin put through the other end of the cork. The points (about one-third inch long) may be cut from any fairly stiff cardboard. A pin should be inserted through the broad end, a little glue or shellac put on the point, and the insect laid upon it with the back outward, and its head away from the preparator when the point is to the left of the pin. Small beetles and true bugs are glued with the back up rather than on the side. It is very important that all specimens be correctly identified before they are permanently assigned to a place in the school collection. Entomologists usually have little two-lined labels printed in diamond type, giving the locality where the specimen was captured and a blank space for writing in the date of capture. These labels are put well up on the pin, a little below the insect, so as not to interfere with the legs. For school purposes labels may be written with a fine pen, care being taken to write them in a small and neat hand. Insects found eating plants should have a little label, giving the name of the plant, and the entomologist also usually places on a label the name of the collector of the specimen. Children should be impressed with the idea that carefulness in these little details counts in the value and usefulness of a collection. Additional information and aid along this line may frequently be had from the State agricultural college or experiment station or from officials of the State department of agriculture.

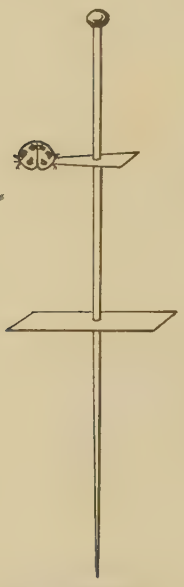


FIG. 9.—Method of mounting small insects.

SPREADING INSECTS.

Insects should be prepared and mounted as soon as possible after they are collected, for if they are left for any length of time the wings and legs will become stiff and easily broken, and it will be impossible to spread the wings as will often be desirable in order to give the specimen a lifelike and attractive appearance. If it should be impossible to mount the specimens until they have become rigid, they can be relaxed by placing them for a time on a piece of paper in a box partly filled with moist sand. It will be well to put a few drops of carbolic acid on the sand in order to prevent molding. After being left in this way for a few days the insects will generally be sufficiently relaxed to make it possible to mount them without great difficulty.

Butterflies and moths, dragon flies, and similar insects should have their wings spread out at right angles to the body. This is done by the use of a spreading board such as is shown in figure 10. Two strips of some soft wood, such as linden, white pine, or white wood, are fastened on low cleats resting on a bottom board. A strip of cork is fastened to the underside of the strips to cover the groove between them. The pin is pushed through the cork until the body of the insect rests upon it, and the wings are then stretched out on the boards by pulling them forward with a pin inserted near the front margin. They should be pulled out far enough so that the hind margin of the front wings will form a straight line. Then the wings should be held in place by strips of paper pinned down tightly at each end. The specimen should remain on the spreading board for at least a week, so that when removed the wings will stay spread and not relax to the normal condition. Care should be taken in placing the strips across the wings, so as not to rub the scales from the wings of butterflies and moths. With grasshoppers it has been customary to spread the wings of one side only.

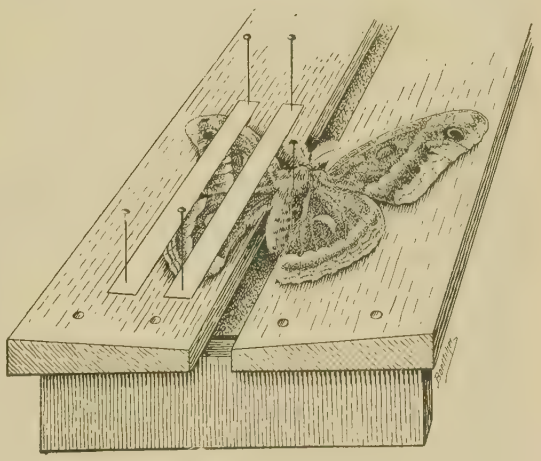


FIG. 10.—Spreading boards.

BOXES.

If it is desired to keep the insects for several years, it is necessary to put them in a tight, dry, and dark box—tight to exclude other insects which would eat them, dry to prevent mold, and dark to preserve their colors.

There are two sizes of boxes commonly used by collectors. One is a box about 9 by 12 inches with a hinged top (fig. 11). These often stand on edge on a shelf. The other is a larger box or drawer about 15 by 18 inches with a removable glass top. These drawers are arranged to slide into a cabinet. Cabinets, with three or more drawers, that will be excellent for school collections, can be purchased from dealers. For the purpose of temporary study insects may be kept in any style of box with a cover. Cigar boxes will do for a time (fig. 12). The bottom of the box should be lined with some soft material, such as cork, peat, well-dried corn pith, or corrugated paper, and covered with soft paper. To prevent other insects from coming in and eating the specimens, a pinch of flake naphthalene or a

FIG. 11.—Covered box for insect specimens.

FIG. 12.—Cigar box for insects.

naphthalene cone should be placed in each box. Within the box the specimens should be arranged, each kind by itself in a row. A label with the name of the insect can be placed behind the row of each species, or attached to the first specimen in the row.

In recent years a new mount has been developed for exhibiting insects and their life histories and it is most excellent for use in schools. It consists of a pasteboard box about one-half inch deep, the top having a glass cover (fig. 13). This box is filled, not too tightly, with cotton. The insect is spread out on the cotton, the top pressed down and held by pins. These mounts can be purchased from dealers and are very useful for passing around in a class, or may be hung as pictures on the walls of the schoolroom. The eggs, caterpillar, chrysalis, and the adult, as well as a part of the plant eaten, can all be put in the same mount and thus exhibit the life history of the insect. To fumigate the specimens perhaps the best way is to place in the box with the specimens a small tin lid or other small shallow vessel and put into it about a tablespoonful of formaldehyde or of carbon bisulphid. The latter substance is inflammable and should not be handled near a fire. The fumes from both these substances are very annoying and disagreeable, hence it will be advisable to do this fumigating out of doors, or in an outbuilding, never in the schoolroom.

The specimens illustrating the life histories of insects will not be complete unless the larvæ are preserved, and it is often in this form that the creature is most injurious to crops. Furthermore, there are some soft-bodied insects, like the spiders, which can not be preserved dry. These specimens must, therefore, be preserved in fluids. A good fluid for this purpose can be made by mixing 10 parts of formalin (40 per cent formaldehyde), 100 parts 95 per cent alcohol, and 100 parts distilled or boiled water.

FIG. 13.—Series of specimens illustrating life history of a moth.

KEEPING LIVE INSECTS—BREEDING CAGES.

One of the most interesting phases of insect study is the rearing of insects. The simplest way is to collect the cocoons attached to various trees in the autumn, and the fine moths, red, brown, or pea-green, will appear the following spring. It is more instructive, however, to collect the larvæ or caterpillars and place them in a box where they can be supplied each day with the proper kind of leaves for food. By this means one can watch the caterpillars change their skins while they grow, and also note the change from the caterpillar to the pupa or chrysalis. Any box with a top of netting to prevent the cater-

pillars from getting out will be suitable. By putting moist sand in the bottom of the box, the food will keep fresh a longer time.

A very convenient and useful breeding cage is made by putting a lamp chimney in a flower pot (fig. 14), the top of the chimney covered with a piece of gauze or mosquito netting. If the pot rests in a saucer containing water the sand or earth in the pot can be kept moist so that twigs of the food plant will remain fresh for some time.

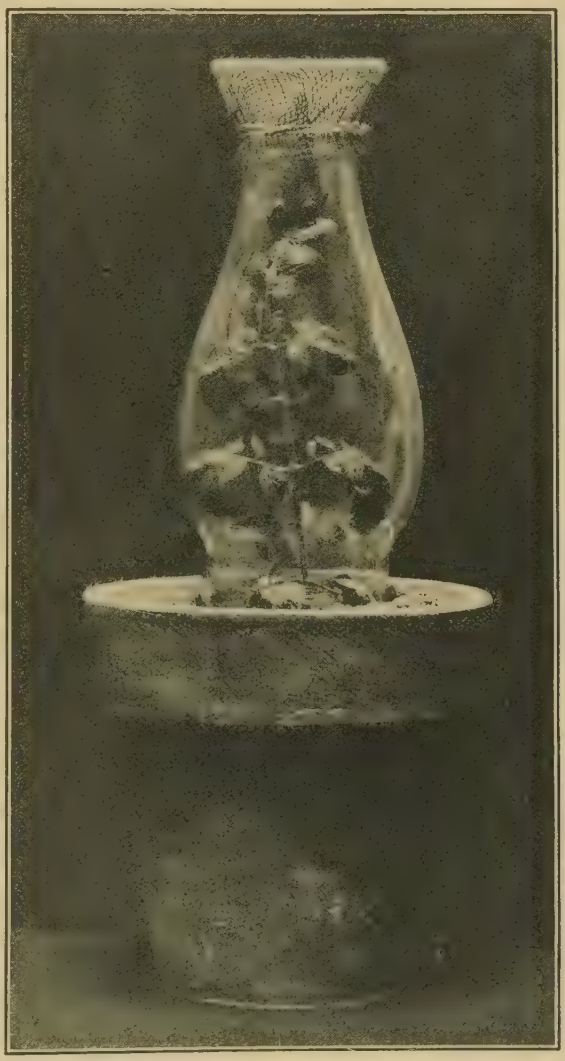


FIG. 14.—A simple breeding cage for insects.

It is interesting to keep ants in an artificial nest. A simple one may be made by taking a piece of board at least 1½ inches thick and about 12 inches square and making a channel 1 inch wide and ¾ of an inch deep all around the near edge. This channel should be nearly filled with water. On the center of the board put two pieces of glass about 8 inches square and between them a thin layer of soil or comminuted wood. Cover the top glass with a blackened board or tin. Ants placed between the plates of glass will excavate tunnels and if fed may be kept a long time.

If galls of insects are collected in the fall or winter many specimens will issue in the spring. Twigs of oak and other trees blown off in the fall or winter may contain beetles, and if placed in a room the

insects will issue and fly to the windows. In rearing moths or other insects one sometimes finds that instead of the expected specimen there appears a quite different insect. This is usually an Ichneumon or Tachina fly. The young of these live parasitically in the caterpillar and destroy it. These parasites should be saved and when possible the name of their insect host should be put on the label.

More extended directions covering special kinds of collecting can be obtained by applying to the United States National Museum, Washington, D. C.

COLLECTION OF ROCK AND SOIL SPECIMENS.

While an exhaustive knowledge of geology is not essential to the study or practice of agriculture, it is important that the student of agriculture should be familiar with the more important types of soils and the processes by which these soils are evolved from mineral or vegetable sources. For this reason the pupils should collect and study specimens of the more important rocks, such as granite, sandstone, and limestone, from which various types of soils are formed by decomposition. These rock specimens should be chipped with a hammer to a convenient size and shape for handling and storing, say, into rectangular blocks about 2½ by 4 inches in area and 1 to 1¼ inches thick at the center. Each specimen should bear a catalogue number or a label indicating the kind of rock and the place of collection. The label itself may be pasted on a smooth surface of the rock or the catalogue number may be painted on it and the description written in a book kept for that purpose. The specimens may be kept in boxes or in trays on cabinet shelves in the schoolroom.

Besides these specimens the pupils should collect, where possible, rock specimens showing evidences of the natural processes by which the rocks are decomposed to form soil. Thus, rocks bearing evidence of weathering, of glacial scratching, or the wearing effect of running water, should be collected and properly described.

To show the process of soil formation by the decay of vegetable matter, go into the forest where there is a deep layer of leaf litter and take up a section of the soil cover down to the mineral soil. Place this in a glass jar, preserving as nearly as possible the positions of the various strata—on the bottom the soft black mold or humus, above this the half-decomposed vegetable matter, and on top the fresh layer of leaves and twigs—thus showing the various stages in the formation of humus.

Collect specimens of all the types of soils found in the vicinity and classify them as sand, clay, silt, loam, or humus. Keep these in glass jars so that their textures and colors may be examined readily. Each jar should, of course, bear a proper label, indicating the type of soil it contains and the place where the specimen was obtained.

OTHER ILLUSTRATIVE MATERIALS.

COMMERCIAL FERTILIZERS.

It will be a good idea for the school to secure samples of commercial fertilizers sold on the local market, keeping these in small bottles, labeled with the name under which the product is sold, and, if possible, its composition.

MANUFACTURED PRODUCTS.

By way of illustrating the commercial importance of farm products interesting collections can be prepared to show the various ways in which these products are utilized in trade. Thus, a series of articles might be prepared to show the products which may be manufactured from corn, such as breakfast foods, corn sirup, cornstarch, corn oil, corn rubber, commercial foods for live stock, paper made from cornstalks, cellulose made from the pith of the stalks, and numerous other articles. In like manner, the uses of other farm products, such as cotton, oats, wheat, and others may be illustrated.

LANTERN SLIDES AND PICTURES.

Nearly every well-equipped school nowadays has facilities for using lantern slides to illustrate special lessons on various topics. No subject presents greater possibilities for the use of slides than agriculture. Slides which will be of interest to agricultural students can be purchased from commercial firms or from other sources, or, if the school can not afford to own a set of slides, there are always opportunities to borrow or rent special sets for temporary use.[1]

Every school in which agriculture is taught ought to own a collection of pictures to illustrate the work. Photographic prints are, of course, the most desirable; but when these can not be obtained, halftone cuts, or even line drawings taken from the pages of agricultural papers and from similar sources, can be used to advantage. In many schools either the teacher or some of the pupils will have cameras, and thus original photographs may be obtained for the collection. It is suggested that these pictures be mounted on good quality gray cardboard mounts of uniform size and filed upright, under convenient classifications indicated by guide cards, in a drawer or letter file. It is not advisable to paste pictures of this sort into a bound scrapbook, since in this form they can not be so readily used by the class.

Some of the kinds of pictures which should be collected are the following: Types of the various breeds of farm animals; views of good farm buildings and well-arranged grounds; good types of farm products, such as well-formed ears of corn; views illustrating the

[1] Sets of lantern slides on various phases of agriculture and agricultural instruction have been prepared by the Division of Agricultural Instruction in Schools of the United States Department of Agriculture. A list of slides with instructions as to how they may be obtained may be had upon application.

working of natural processes of importance agriculturally, such as soil erosion; views of different kinds of farm machinery and equipment; views illustrating experiments and demonstration field work carried on by the school. Especially interesting are pictures which show contrasts of good and bad farming methods. It will be found that a good picture collection of this sort will prove to be exceedingly useful.

CHARTS AND MAPS.

Much more use can be made of charts in the teaching of agriculture than is usually done. They can be used to record formulas and data which may be wanted again at some future time, but which are likely to be lost if placed on the blackboard where they may be erased. Thus, plans for the reorganization of farms of the vicinity may be worked out by the pupils and charted for future reference; schemes for proper system of crop rotation on these farms may also be charted; formulas for fertilizer compounds or spraying mixtures may be written on a chart and kept for reference; and drawings of various kinds, such as those showing the various cuts in a beef carcass, may thus be prepared for general use (fig. 15).

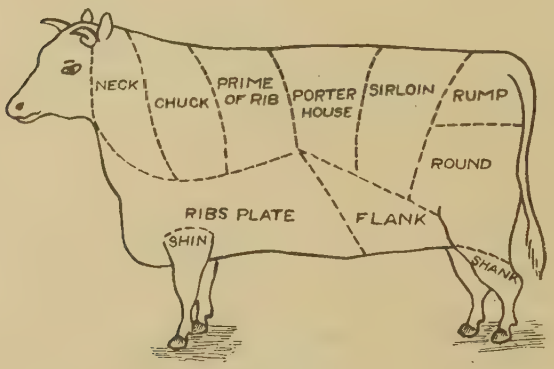


FIG. 15.—Chart showing cuts of beef.

A good chart can be made by the use of heavy manila paper cut into sheets of convenient size, such as 2½ by 3 feet, these sheets being fastened together at one end by nailing them between two pieces of lath. Screw eyes fastened in the ends of one of these laths with a cord tied to them will serve to support the chart on the wall.

Maps for use in the study of agriculture should be chiefly local in character. For most regions topographical maps and soil maps may be obtained. It will be well also to have a map of the forest land of the locality if possible to obtain one.

USE OF THE BLACKBOARD.

Teachers who appreciate the value of visual instruction make extensive use of the blackboard. All teachers of agriculture should have sufficient training in drawing to enable them, with little time and effort, to make such simple drawings as outlines of insects and rough plans of farms and buildings. Many topics may be diagramed effect-

ively or otherwise shown in a graphic way. Formulas and statements involving figures are more impressive if placed on the blackboard before the students. Often the main points or a summary of the lesson may be written on the board in terse terms, so that the students may grasp the thought in a better way. Sometimes the outline of a special topic, or even an outline of the whole lesson, may be profitably placed on the board by teacher or students. Some very successful teachers have the reputation of "talking with chalk," which means that the oral statements of the class are reinforced or supplemented with illustrations or statements on the blackboard. With such teachers both the eye-minded and the ear-minded students have an opportunity. It is well to leave a good deal of the blackboard work to the students, so that they may profit by doing as well as seeing.

HOW TO USE A SOIL SURVEY MAP.

A large number of soil surveys have been made in the United States, and many of the schools are in areas where soil maps are available. The first thing to study is the scale—what the scale is, and what it means. The scale is given at the bottom of the map. Usually 1 inch represents a mile. Let the students measure the distance between two roads or between a house and the road about a mile away, or a bend in the road, measuring it on the map in inches and in the field in feet. Give them the number of feet to the mile, and let them check up the distance on the map and on the field.

The next thing is direction. Soil maps always are drawn so that the upper edge is toward the north, and everything is drawn from this position. If there is a compass in the schoolhouse, put it on the map and turn the map until its edge is exactly in the direction of the compass needle. Make all observations with the map in this position. If there is no compass, select a distinct object on the map, such as a crossroads, church, or house, and place the map so that the direction from the school to the object on the map is in line with the same direction in the field. In making observations on the map always hold it in this position. Measure the distance along the line from the schoolhouse to a point in the road. Carry the map to that point, fix it in the original position, and see if the turn in the road corresponds to the way it is drawn on the map. This gives an idea both of distance and of direction as platted on the map to represent actual conditions in the field.

Differences of soil should be noted. The soils around the school are recognized by name as representing certain soil types. Some distance away from the school, in a certain relation to roads or houses, a different type of soil is recorded on the map. One may be a sand

and the other a clay soil. The descriptions of each are given in the report. Have the children visit those two sections and compare the soils.

The report may state that a sand soil may be adapted to certain crops and not to other crops to which the clay soil is adapted. A sand soil is not so retentive of moisture, and therefore it does not keep as moist as the clay soil. If these two soils are examined during wet periods and during dry periods, the differences in their moisture content and their relation to moisture can be made apparent to the children, who can be brought to see that these differences frequently are of influence in making one soil adapted to one crop and another to another crop.

Explain the purpose of the soil map as giving a minute representation of actual soil differences. Show how this differs from an ordinary geological map, in which colors are used to convey different meanings. Show why it is that different symbols are used for county or township boundaries, for roads, for railroads, for villages, and for houses, so that at a glance one can see what these physical features are by the form of the symbol used. Indicate that certain colored soils always run along the stream channels; others are only found on the higher ridges; that the form of the surface and the way the soil has been deposited have much to do with the distribution of the soils of the county.

THE AGRICULTURAL MUSEUM.

If future needs are kept in mind, permanent collections will be made of plants of all kinds, insects and small animals, rocks, minerals, soils, fertilizers, seeds, and various plant and animal products. Educational exhibits of the last-mentioned materials often are furnished free of charge by manufacturers.

Some of the colleges and laboratory supply houses furnish agricultural exhibits at a nominal cost, but it should be borne in mind that a great deal of interest will be aroused and much will be learned by the students in collecting material. The teacher should not fail to take advantage of the collecting instinct of his students. In time an agricultural museum will be established which will not be a repository for curiosities, but a collection of materials useful in teaching. Time is often wasted and valuable material lost because proper provision is not made for taking care of collections. The students may have the making of cabinets and cases as a part of their manual training or farm mechanics work. Special attention should be given to protection from mice and insect pests which destroy stored products and mounted specimens.

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